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EXAMINER

HUR, JUNG H

ART UNIT PAPER NUMBER

2824

DATE MAILED: 11/04/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

AYO

Office Action Summary

Application No.

10/068,465

Applicant(s)

ZHU ET AL.

Examiner

Jung (John) Hur

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-- The MAILING DATE of this communication appears on the cover sheet with the corresponding address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 September 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-32 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 4 and 30-32 is/are allowed.
- 6) ☒ Claim(s) 1-3 and 5-29 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 06 February 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

Amendment

1. Acknowledgment is made of applicant's Amendment, filed 16 September 2003. The changes and remarks disclosed therein were considered.

Claims 1-32 are pending in the application.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-3, 5, 6, 10-20 and 23-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heim et al. (U.S. Pat. No. 5,465,185) in view of Koch et al. (U.S. Pat. No. 6,005,800).

Regarding claims 1, 2, 5, 6, 10-12, 14, 17-20, 23 and 24, Heim in Fig. 5 discloses a magneto-resistive memory cell (column 3, lines 20-24), comprising: a free magnetic layer (63); a non-magnetic interlayer (65), wherein the non-magnetic interlayer comprises a conductor (copper) and is in contact with the free magnetic layer; a pinned magnetic layer (72), wherein the pinned magnetic layer is in contact with the non-magnetic interlayer; and an additional pinned magnetic layer (74); wherein the pinned magnetic layer is between the free magnetic layer and the additional pinned magnetic layer; wherein the additional pinned magnetic layer comprises a ferromagnetic material (Ni-Fe) with magnetization orientation pinned by an adjacent layer (66)

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comprising an antiferromagnetic material (Fe-Mn); wherein the pinned magnetic layer and the additional pinned magnetic layer are separated by a separating layer of ruthenium (73); and wherein the pinned magnetic layer and additional pinned magnetic layer have preselected thicknesses such that a magnitude of a magnetic field of the pinned magnetic layer is substantially equal to a magnitude of an additional magnetic field of the additional pinned magnetic layer, and a magnetization orientation of the pinned magnetic layer is substantially anti-parallel (opposite) to a magnetization orientation of the additional pinned magnetic layer such that a magnitude of a net magnetic field from the pinned magnetic layer and the additional pinned magnetic layer is too small to substantially affect a magnetization orientation of the free magnetic layer (for example, column 5, lines 49-61).

However, Heim does not specifically disclose that the magneto-resistive memory cell is electrically connected to a sense line conductor and a write line conductor at an intersection of the sense line conductor and the write line conductor, wherein the sense line conductor is oriented perpendicular to the write line conductor.

Koch in Fig. 8 discloses a magneto-resistive memory cell (for example, 40') electrically connected to a sense line conductor (for example, 32'; see also column 10, lines 8-12) and a write line conductor (for example, 33'; see also column 10, lines 6-9) at an intersection of the sense line conductor and the write line conductor, wherein the sense line conductor is oriented perpendicular to the write line conductor (Fig. 8; see also column 10, lines 6-12 which discloses that these lines are parallel to Y-axis and X-axis, thus perpendicular to each other).

Since Heim clearly teaches that its magneto-resistive element is also applicable as a magneto-resistive memory cell (column 3, lines 20-24), it would have been obvious at the time

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the invention was made to a person having ordinary skill in the art to electrically connect a sense line and a write line to the magneto-resistive memory cell of Heim, so that information can be read from and written to the magneto-resistive element. Further, it would have been obvious to orient the sense line perpendicular to the write line, as in Koch, since such orientation of sense lines and write lines was common and well known in the art (see also Fig. 1A of Heim).

Regarding claims 3, 15 and 16, Heim discloses a magneto-resistive memory cell as in claims 1 and 14 above, with the exception of a first magnitude of an applied magnetic field for switching the magnetization orientation of the free magnetic layer in a first direction is about 75-125 percent or about 90-110 percent (or, in the case of minimum magnitudes, about 80-120 percent) of a second magnitude of an applied magnetic field for switching the magnetization orientation of the free magnetic layer in a direction substantially opposite to the first direction. In light of an objective of maximizing the sensitivity of the structure of Heim (see, for example, column 2, lines 50-53), it would have been obvious at the time the invention was made to a person having ordinary skill in the art to adjust the thickness of the pinned layers of Heim to minimize the net magnetic field effect of pinned layers on the free layer (see, for example, column 5, lines 54-61), such that the magnetization orientation of the free layer switches nearly symmetrically, i.e., the first switching field magnitude is about 100 percent of the second magnitude (which would be about 75-125 percent or about 90-110 percent, or, in the case of minimum magnitudes, about 80-120 percent), since it was held that determining an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding claim 13, Heim discloses a magneto-resistive memory cell as in claim 12 above, with the exception of the cell formed within a giant magneto-resistive (GMR) memory array. Koch discloses a magnetic random access memory (MRAM) array wherein the memory cells, comprising ferromagnetic layers separated by a layer of nonmagnetic metal (similar to the structure of Heim), operate on the basis of GMR (column 1, lines 19-29). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to form the magneto-resistive memory cell of Heim in a GMR memory array, since a GMR operation of a structure comprising ferromagnetic layers separated by a layer of nonmagnetic metal (similar to that of Heim) was well known and common in the art (see also Heim, column 1, lines 32-36, and the instant specification, page 2, paragraph 4).

Regarding claims 25-29, Heim in Fig. 5 and in column 5, lines 3-35 discloses a method of constructing a magneto-resistive memory cell, comprising: selecting a ferromagnetic material (Ni-Fe) for a first magnetic layer (72); selecting an additional ferromagnetic material (additional Ni-Fe) for a second magnetic layer (74); selecting thicknesses for each of the first magnetic layer and the second magnetic layer such that a magnitude of a magnetic field of the first magnetic layer is substantially equal to a magnitude of a magnetic field of the second magnetic layer (column 5, lines 49-61); forming a non-magnetic interlayer, wherein the non-magnetic interlayer comprises copper (65); forming the first magnetic layer (72); forming the second magnetic layer (74) without forming another magnetic layer between the first magnetic layer and the second magnetic layer (no ferromagnetic or antiferromagnetic layer in between); forming a

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first fixed magnetic layer by applying a first magnetic field to fix a magnetization orientation of the first magnetic layer (for example, column 5, lines 24-28); and forming a second fixed magnetic layer by applying a second magnetic field to fix a magnetization orientation of the second magnetic layer in an opposite direction from the magnetization orientation of the first magnetic layer (for example, column 5, lines 24-28 and Fig. 5), wherein the first magnetic layer and the second magnetic layer are formed sequentially (column 5, lines 16-24), wherein the first magnetic layer and the second magnetic layer are formed of substantially the same ferromagnetic material and have substantially the same thickness (column 5, lines 54-58).

However, Heim does not specifically disclose forming a conductive sense line and a conductive write line in electrical contact with the magneto-resistive memory cell, wherein the memory cell is formed at an intersection of the conductive sense line and the conductive write line and wherein the sense line conductor is formed perpendicular to the write line conductor.

Koch in Fig. 8 discloses forming a conductive sense line (for example, 32'; see also column 10, lines 8-12) and a conductive write line (for example, 33'; see also column 10, lines 6-9) in electrical contact with a magneto-resistive memory cell (for example, 40'), wherein the memory cell is formed at an intersection of the conductive sense line and the conductive write line and wherein the sense line conductor is formed perpendicular to the write line conductor (Fig. 8; see also column 10, lines 6-12 which discloses that these lines are parallel to Y-axis and X-axis, thus perpendicular to each other).

Since Heim clearly teaches that its magneto-resistive element is also applicable as a magneto-resistive memory cell (column 3, lines 20-24), it would have been obvious at the time the invention was made to a person having ordinary skill in the art to form a conductive sense

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line and a conductive write line in electrical contact with the magneto-resistive memory cell of Heim, so that information can be read from and written to the magneto-resistive element.

Further, it would have been obvious to form the sense line perpendicular to the write line, as in Koch, since such perpendicular formation of sense lines and write lines was common and well known in the art (see also Fig. 1A of Heim).

3. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Heim et al. (U.S. Pat. No. 5,465,185) in view of Koch et al. (U.S. Pat. No. 6,005,800) as applied to claim 7 above, and further in view of Haratani et al. (U.S. Pat. No. 6,144,524).

Regarding claim 7, Heim discloses a magneto-resistive memory cell as in claim 5 above, with the exception of the adjacent layer comprising a permanent magnet material. Haratani discloses a permanent magnet layer as a replacement for an antiferromagnetic layer for fixing the magnetization direction of a pinned layer (for example, column 5, lines 39-44). Since these two means of fixing the magnetization direction of a pinned layer were art-recognized equivalents at the time the invention was made, one of ordinary skill in the art would have found it obvious to substitute a permanent magnet material for the adjacent layer of Heim.

4. Claims 8, 9, 21 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heim et al. (U.S. Pat. No. 5,465,185) in view of Koch et al. (U.S. Pat. No. 6,005,800) as applied to claims 1 and 19 above, and further in view of Anthony et al. (U.S. Pat. No. 6,172,904).

Regarding claims 8, 9, 21 and 22, Heim discloses a magneto-resistive memory cell as in claims 1 and 19 above, with the exception of the pinned magnetic layer (or a layer of the pair of

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pinned magnetic layers) comprising a permanent magnet, or the additional pinned magnetic layer (or a layer of the pair of pinned magnetic layers) comprises a ferromagnetic material with coercivity sufficiently high such that its magnetization orientation remains fixed in the presence of an applied magnetic field of a magnitude sufficient to switch the magnetization orientation of the free magnetic layer. Anthony discloses that a pinned layer (50 or 54 of Fig. 2) is alternatively a reference layer pinned by an antiferromagnetic layer or a permanent magnet layer (see, for example, column 3, lines 49-61). Since these two means of providing a pinned layer were art-recognized equivalents at the time the invention was made, one of ordinary skill in the art would have found it obvious to substitute a permanent magnet for a pinned layer of Heim. Further, it was well known in the art that a permanent magnet comprises a ferromagnetic material with coercivity sufficiently high such that its magnetization orientation remains fixed in the presence of an applied magnetic field of a magnitude sufficient to switch the magnetization orientation of the free magnetic layer.

Allowable Subject Matter

2. Claims 4 and 30-32 are allowed.

The reasons for the indication of allowable subject matter are on record in the file.

Response to Arguments

3. Applicant's arguments with respect to claims 1, 14, 19 and 25 have been considered but are moot in view of the new ground(s) of rejection necessitated by applicant's amendment.

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Specifically, the amended claims 1, 14, 19 and 25 now recites “a sense line conductor” (or “a conductive sense line” in claim 25) and “a write line conductor” (or “a conductive write line” in claim 25). These limitations are newly claimed subject matter, necessitating further consideration.

Conclusion

4. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.


5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jung (John) Hur whose telephone number is (703) 308-1624. The examiner can normally be reached on M-F 6:30 AM - 3:00 PM.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Elms can be reached on (703) 308-2816. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

jhh


RICHARD ELMS
PATENT EXAMINER